1-6

JP Kokai Hei 11-64377

## Title of the Invention

Lamination-Type Connector and Adapter Device for Use in Circuit Substrate Inspection

## Abstract

Object: To provide a lamination-type connector which makes it possible to easily form a wiring unit with a great degree of freedom and to positively achieve a connection between a via hole land of the wiring unit of a substrate and a short-circuiting unit of an insulating layer, and an adapter for use in a circuit substrate inspection, which is provided with such a connector.
Solving Means: A lamination-type connector comprises: a substrate having a top surface on which a wiring unit having a via hole land is formed; and at least one insulating layer which is superposed on the substrate including this wiring unit, wherein a short-circuiting unit which is connected to the via hole land in the wiring unit of the substrate and which extends in a manner so as to penetrate the insulating layer in its thickness direction is formed on the insulating layer, and the short-circuiting unit includes: a metal post which is formed so as to stick out upward from the via hole land in the wiring unit of the substrate; and an intermediate conductor which extends downward from the top surface of the insulating layer and which is joined to the upper portion of the metal post. The adapter device is formed by integrally placing an anisotropic conductive elastomer layer on the top surface of the adapter main body which is made of the above-mentioned

lamination-type connector.

Claims

1. A lamination-type connector comprising:

a substrate having a top surface on which a wiring unit having a via hole land is formed; and

at least one insulating layer which is superposed on the substrate including this wiring unit, wherein

a short-circuiting unit, which is connected to the via hole land in the wiring unit of the substrate and which extends in a manner so as to penetrate the insulating layer in the thickness direction thereof, is formed on the insulating layer, and

the short-circuiting unit includes:

a metal post which is formed so as to stick out upward from the via hole land in the wiring unit of the substrate; and

an intermediate conductor which extends downward from the top surface of the insulating layer and which is joined to the upper portion of the metal post.

2. An adapter device for use in a circuit substrate inspection, which is interpolated between an inspection subject circuit substrate and an electrical inspection device so as to electrically connect an electrode to be inspected of the circuit substrate and the electrical inspection device, comprising:

an adapter main body having a terminal electrode which is placed on

a grid point on a lower surface thereof, and a connecting electrode which corresponds to the electrode to be inspected of the inspection subject circuit substrate on an upper surface thereof; and

an anisotropic conductive elastomer layer which is integrally formed on the upper surface of the adapter main body, wherein

the adapter main body comprises the lamination-type connector according to claim 1,

the short-circuiting unit formed on the insulating layer is electrically connected to the connecting electrode, and

the wiring unit of the substrate is electrically connected to the terminal electrode.

Detailed Description of the Invention

[0001]

Technical Field of the Invention

The present invention relates to a lamination-type connecter and a circuit substrate inspection-use adapter device having such a lamination-type connector.

[0002]

Prior Art

In general, as shown in Fig. 21, in a circuit substrate such as a printed circuit board, a functional element area 91 in which functional elements are formed with a high degree of integration is placed in the center portion of a circuit substrate 90, and a lead electrode area 93, which is formed by arranging a number of lead electrodes 92 used for the functional element area 91, is placed on the peripheral portion thereof. Here, at

present, along with an increase of the degree of integration in the functional element area 91, the number of the lead electrodes of the lead electrode area 93 tends to increase to have a high density.

[0003]

In order to electrically connect the lead electrodes of such a circuit substrate to other circuit terminals and the like to be connected thereto, conventionally, an anisotropic conductive sheet is interpolated and placed on each lead electrode area. This anisotropic conductive sheet is allowed to exert conductivity only in the thickness direction, or has a number of pressure-conductive conductor units which exert conductivity only in the thickness direction upon application of a pressure; and those having various structures have been disclosed in, for example, JP Publication Shou 56-48951, JP Kokai Shou 51-93393, JP Kokai Shou 53-147772, JP Kokai Shou 54-146873, etc.

[0004]

Here, the above-mentioned anisotropic conductive sheet is manufactured as an independent product, and handled as an independent manner so that it is necessary for the sheet to be held and secured to the circuit substrate with a specific positional relationship in its electrical connecting processes. However, with respect to means for achieving an electrical connection on the circuit substrate by utilizing the independent anisotropic conductive sheet, the problem is that as the array pitch (hereinafter, referred to as "electrode pitch") of lead electrodes in a circuit substrate to be inspected, that is, the center-to-center distance of adjacent lead electrodes, becomes smaller, the positioning of the anisotropic

conductive sheet and holding and securing processes thereof become difficult.

[0005]

Moreover, even in the case when desired positioning thereof and holding and securing processes thereof have been once achieved, upon receipt of a thermal history and the like due to temperature changes, since there is a difference in the degree of stress due to thermal expansion and thermal shrinkage between the material constituting the circuit substrate to be inspected and the material forming the anisotropic conductive sheet, it is difficult to maintain a stable connection state due to changes in the electrical connection state.

[0006]

Moreover, even in the case when a stable connection state is maintained with respect to a circuit substrate to be inspected, with respect to a circuit substrate having a group of electrodes to be inspected with a complex, fine pattern, such as a printed circuit board having a high packaging density, it is difficult to positively achieve electrical connections between the respective electrodes to be inspected; consequently, it is not possible to carry out necessary inspections sufficiently.

[0007]

Conventionally, in order to solve the above-mentioned problems, an adapter device for use in a circuit substrate inspection has been proposed in which: an adapter main body which has terminal electrodes arranged on standardized grid points is formed on the lower surface thereof, with connecting electrodes corresponding to the electrodes to be inspected of the inspection subject circuit substrate being formed on the upper surface

thereof, and an anisotropic conductive elastomer layer is integrally formed on the upper surface of this adapter main body.

[0008]

With this arrangement, even in the case when inspection subject electrodes such as lead electrodes on the circuit substrate to be inspected have fine pitches with a fine, complex pattern having a high density, it is possible to positively achieve necessary electric connections with respect to the circuit substrate, and also to maintain a superior electrical connection state in a stable manner even under environmental changes such as thermal history due to temperature changes; thus, it becomes possible to provide an adapter device for use in circuit substrate inspection which is really advantageous in the connection reliability.

[0009]

Problems to be Solved by the Invention

In such an adapter device for use in circuit substrate inspection, connecting electrodes, which have a pattern corresponding to inspection subject electrodes of a circuit substrate to be inspected, that is, a complex pattern with fine electrode pitches, need to be electrically connected to terminal electrodes arranged on standard grid points with electrode pitches of, for example, 2. 54 mm, 1. 80 mm or 1. 27 mm; therefore, a lamination-type connector, which has an arrangement in which, on a substrate having an appropriate wiring unit on its upper surface, an insulating layer having a short-circuiting unit connected to the wiring unit of the substrate is superposed, is used as an adapter main body. Moreover, in such a lamination-type connector, with respect to a method for forming the short-

circuiting unit on the insulating layer, in general, a through hole method is adopted. In this through hole method, a connector-use lamination for the substrate and the insulating layer is formed, and with respect to this connector-use lamination, a through hole which penetrates it in its thickness direction is formed by using, for example, a drilling device, and copper deposition is formed on the inner face of the through hole by using, for example, a copper plating method.

[0010]

However, in such a through hole method, since a conductor which is not used needs to be formed as the short-circuiting unit, and since a drill having high strength, which is, a drill having a great diameter, has to be used in order to form a through hole which penetrates the entire lamination, the resulting problems is that it becomes difficult to form a short-circuiting unit having a small outer diameter in the insulating layer; consequently, it becomes difficult to form a wiring unit on the upper surface of the wiring unit and the insulating layer on the substrate surface with a high degree of freedom, and in the case of an electrode to be inspected on the circuit substrate to be inspected having an extremely high density, in order to manufacture a lamination-type connector to be applied to such an electrode, it is necessary to increase the number of the insulating layers, resulting in an increase in time and costs required for a wiring design as well as for manufacturing the adapter main body.

[0011]

Here, with respect to a method for forming a short-circuiting unit in addition to the through hole method, a method using so-called blind via holes

(hereinafter, referred to as "blind via hole method") has been known. In this blind via hole method, for example, a numeric-value controlling-type drilling device is used so that a drill hole (blind via hole) is formed only in the insulating layer in the above-mentioned connector-use lamination, and metal deposition is formed on the inner face of this drill hole. Therefore, in the case when the short-circuiting unit of the insulating layer is formed on a position right above the via hole land of the wiring unit of the substrate, the following problems are raised.

(1) The drill hole, formed in the insulating layer, needs to have a depth in such a range that it is allowed to reach the via hole land from the upper surface of the insulating layer without penetrating the via hole land, and since the thickness of the via hole land is approximately 10 $\mu$ m, it is very difficult to positively form a necessary drill hole.

(2) In order to form the wiring unit of the insulating layer with a high degree of freedom, it is essential to form a short-circuiting unit having a small outer diameter in the insulating layer; however, when, in an attempt to form such a short-circuiting unit having a small outer diameter in the insulating layer, a drill hole having an inner diameter smaller than the inner diameter of the via hole land is formed, it is not possible to form a short-circuiting unit which is connected to the via hold land, with the result that it becomes difficult to positively achieve a necessary inter-layer connection.

[0012]

The present invention has been devised to solve the above-mentioned problems, and an first object thereof is to provide a lamination-type connector which is used for inspecting a circuit substrate, and makes it

possible to easily form a wiring unit with a high degree of freedom even when an electrode to be inspected such as a lead electrode and the like in a circuit substrate to be inspected has a fine electrode pitch with a fine, complex pattern having a high density, and also to positively connect the via hole land of the wiring unit of the substrate and the short-circuiting unit of the insulating layer. A second object of the present invention is to provide an adapter device for use in circuit substrate inspection which makes it possible to positively achieve a necessary electrical connection with respect to the circuit substrate, to maintain a superior electrical connection state in a stable manner even upon receipt of a thermal history and the like due to temperature changes, even in the case when an electrode to be inspected such as a lead electrode in a circuit substrate to be inspected has a fine electrode pitch with a fine, complex pattern with a high density, and consequently to positively carry out manufacturing processes advantageously with high connecting reliability.

[0013]

Means for Solving the Problems

A lamination-type connector of the present invention comprises: a substrate having a top surface on which a wiring unit having a via hole land is formed; and at least one insulating layer which is superposed on the substrate including this wiring unit, wherein a short-circuiting unit, which is connected to the via hole land in the wiring unit of the substrate and which extends in a manner so as to penetrate the insulating layer in the thickness direction thereof, is formed on the insulating layer, and the short-circuiting unit includes: a metal post which is formed so as to stick out upward from

the via hole land in the wiring unit of the substrate; and an intermediate conductor which extends downward from the top surface of the insulating layer and which is joined to the upper portion of the metal post.

[0014]

Moreover, the above-mentioned lamination-type connector is manufactured by a method including a first step in which, after a wiring unit having a via hole land has been formed on the upper surface of the substrate, a metal host is formed in a manner so as to stick out upward from the via hole land of the wiring unit, a second step in which an insulating layer is formed on the top surface of the substrate containing the above-mentioned wiring unit and metal post, and a third step in which a hole is formed at the position having the metal post in the above-mentioned insulating layer with a depth reaching the metal post, with an intermediate conductor being formed inside this hole so that a short-circuiting unit which is connected to the via hole land on the above-mentioned wiring unit, and extends in a manner so as to penetrate the insulating layer in its thickness direction is formed.

[0015]

An adapter device for use in a circuit substrate inspection, which is interpolated between an inspection subject circuit substrate and an electrical inspection device so as to electrically connect an electrode to be inspected of the circuit substrate and the electrical inspection device, comprises: an adapter main body having a terminal electrode which is placed on a grid point on a lower surface thereof, and a connecting electrode which corresponds to the electrode to be inspected of the inspection subject circuit

substrate on an upper surface thereof; and an anisotropic conductive elastomer layer which is integrally formed on the upper surface of the adapter main body, wherein the adapter main body comprises the above-mentioned lamination-type connector, the short-circuiting unit formed on the insulating layer is electrically connected to the connecting electrode, and the wiring unit of the substrate is electrically connected to the terminal electrode.

[0016]

Embodiment of the Present Invention

The following description will discuss the present invention in detail. Fig. 1 is a cross-sectional view which explains a structure of one example of a lamination-type connector of the present invention, Fig. 2 is a partial planer view which explains a layout of respective units of the lamination-type connector, and Fig. 3 is an enlarged cross-sectional view which explains one portion of the lamination-type connector. As shown in Fig. 1, this lamination-type connector is constituted by a substrate 10, an upper portion insulating layer 20 which is superposed on the upper surface of the substrate 10 and a lower portion insulating layer 30 which is superposed on the lower surface of the substrate 10. The material of the substrate 10 is preferably prepared as a plate-shaped member made of a heat resisting material having high dimensional stability, and various insulating resins may be used, and in particular, a glass fiber reinforcing type epoxy resin is most preferably used. The upper portion insulating layer 20 and the lower portion insulating layer 30 are formed by a thermosetting resin sheet which is formed by, for example, a heat press-bonding process. This thermosetting resin sheet is preferably

formed by a heat-resisting resin having high dimensional stability, and various resin sheets may be used, and, in particular, a glass fiber reinforcing type epoxy prepreg resin sheet, a polyimide prepreg resin sheet and an epoxy prepreg resin sheet are preferably used.

[0017]

On the upper surface of the substrate 10, an upper-side wiring unit 11 having a desired pattern with a via hole land 12 having, for example, a round shape is formed, and on the lower surface of the substrate 10, a lower-side wiring unit 13 having a desired pattern with a via hole land 14 having, for example, a round shape is formed; thus, the upper-side wiring unit 11 and the lower-side wiring unit 13 are electrically connected to each other through a substrate short-circuiting unit 15 having, for example, a cylinder shape which extends in a manner so as to penetrate the substrate 10 in its thickness direction. This substrate short-circuiting unit 15 is formed at each of positions, such as a position right under the via hole land 12 of the upper-side wiring unit 11, a position right above the via hole land 14 of the lower-side wiring unit 13, and an appropriate position between the upper-side wiring unit 11 and the lower-side wiring unit 13. Here, the term, "via hole land" refers to a land formed on a via hole, that is, a land formed on the substrate short-circuiting unit.

[0018]

On the upper surface of the substrate 10 including the upper-side wiring unit 11, an upper-side insulating layer 20 is formed. On the upper surface of this upper-side insulating layer 20, connecting electrodes 21 are formed on positions corresponding to a pattern of the electrodes to be

inspected (not shown) of a circuit substrate to be inspected, in a manner so as to stick out from the upper surface, with an upper-surface wiring unit 22 having a desired pattern being also formed thereon. Further, on the upper-side insulating layer 20, a short-circuiting unit 23, which has, for example, a cylinder shape, and extends in its thickness direction in a manner so as to penetrate it, is formed. The upper end of the short-circuiting unit 23 is connected to the connecting electrode 21 directly, or through the upper-surface wiring unit 22, while the lower end of the short-circuiting unit 23 is connected to the via hole land 12 of the upper side wiring unit 11 or a desired portion of the upper-side wiring unit 11; thus, the connecting electrode 21 is electrically connected to the upper-side wiring unit 11.

[0019]

As shown in Fig. 3, the short-circuiting unit 23 of the upper-side insulating layer 20 is provided with metal posts 24 each of which has a fine cylinder shape, and is formed at a desired portion of the via hole land 12 of the upper-side wiring unit 11 and the upper-side wiring unit 11, in a manner so as to stick out upward from the upper-side wiring unit 11 and a cylinder-shaped intermediate conductor 25 which has an outer diameter greater than the inner diameter of a cylinder hole 24H of the metal post 24, and extends downward from the upper surface of the upper-side insulating layer 20 to be joined to the upper portion of the metal post 24, and the upper end of this intermediate conductor 25 is connected to the connecting electrode 21 directly or through the upper surface wiring unit (not shown).

[0020]

On the lower surface of the substrate 10 including the lower-side

wiring unit 13, a lower-side insulating layer 30 is formed. On the lower surface of this lower-side insulating layer 30, terminal electrodes 31, which are electrically connected to an electric inspection device, that is, a detecting tester through a desired means, are formed so as to be arranged on grid points, and these terminal electrodes 31 are electrically connected to proper portions on the via hole land 14 of the lower-side wiring unit 13 of the substrate 10 or the lower-side wiring unit 13. The distance between grid points relating to the terminal electrode 31, that is, an electrode pitch between the terminal electrodes 31, is not particularly limited, and made to have a desired size depending on various conditions, and the size is set to, for example, 2.54 mm, 1.8 mm or 1.27 mm.

[0021]

Here, each of the connecting electrodes 21 is electrically connected to a terminal electrode 31 through a short-circuiting unit 23 (the intermediate conductor 25 and the metal post 24) of the upper-side insulating layer 20, the upper-side wiring unit 11, the substrate short-circuiting unit 15, the lower-side wiring unit 13 and the short-circuiting unit 32 of the lower-side insulating layer 30. In Fig. 1, the upper-side wiring unit 11 and the lower-side wiring unit 13 of the substrate 10 as well as the upper-surface wiring unit 22 of the upper-side insulating layer 20 are of course formed in a state so as to extend in a direction orthogonal to the drawing face, and Fig. 2 shows such a state.

[0022]

In an actual structure, the electrical connection between the connecting electrode 21 and the terminal electrode 31 may be achieved in a

mode which corresponds to the inspection purpose of the circuit substrate. Therefore, all the connecting electrodes 21 and terminal electrodes 31 are not necessarily connected to a one-to-one correspondence; and with respect to the connecting electrode 21, the upper-surface wiring unit 22, the upper side wiring unit 11, the lower side wiring unit 13 and the terminal electrode 31, various desired connection modes may be achieved. For example, the following connection modes may be proposed in which: electrodes 21 which are connected to each other are connected by utilizing the upper surface wiring unit 22; a plurality of connecting electrodes 21 are commonly connected to one upper-side wiring unit 11; and one connecting electrode 21 is connected to a plurality of upper-side wiring units 11 simultaneously.

[0023]

The lamination-type connector having the above-mentioned structure is manufactured by using the following steps: (1) a first step in which, after the upper-side wiring unit 11 having the via hole land 12 has been formed on the upper surface of the substrate 10, a metal host 24 is formed in a manner so as to stick out upward from the via hole land 12 of the upper-side wiring unit 11, (2) a second step in which an upper insulating layer 20 is formed on the top surface of the substrate 10 containing the upper-side wiring unit 11 and the metal post 24, and (3) a third step in which a hole is formed at the position having the metal post 24 in the upper insulating layer 20 with a depth reaching the metal post 24, with an intermediate conductor 25 being formed inside this hole, so that a short-circuiting unit 23 which is connected to the via hole land 12 on the upper-side wiring unit 11, and extends in a manner so as to penetrate the upper

insulating layer 20 in its thickness direction is formed.

[0024]

The first to third steps will be described in detail as follows. First step: in this first step, as shown in Fig. 6 in its final structure, on the upper surface of the substrate 10, the upper side wiring unit 11 having the via hole land 12 is formed, and the metal post 24 is also formed in a manner so as to stick out from desired portions of the via hole land 12 of the upper-side wiring unit 11 and the upper-side wiring unit 11, with a substrate short-circuiting unit 15 being formed to extend in a manner so as to penetrate the substrate 10 in the thickness direction thereof, and the lower-side wiring unit 13 having a via hole land 14 is further formed on the lower surface of the substrate 10.

[0025]

More specifically, as shown in Fig. 4, a flat-plate-shaped insulating substrate 10, made of a hard resin with metal thin layers 11A and 13A made of, for example, copper being laminated on both of the surfaces, is prepared, and as shown in Fig. 5, a substrate short-circuiting unit forming hole 15H which penetrates the substrate 10 in the thickness direction is formed in the substrate 10 by using, for example, a numeric-value-control type drilling device. Next, as shown in Fig. 6, electroless copper plating and electrolytic copper plating are applied to the above-mentioned substrate 10 so that copper deposition is formed on the inner face of the substrate short-circuiting unit forming hole 15H so that the cylinder-shaped substrate short-circuiting unit 15 which extends in a manner so as to penetrate the substrate 10 in its thickness direction is formed. Moreover, photolithography and etching

processes are carried out on a metal thin layer 11A on the upper surface of the substrate 10 so as to remove one portion thereof so that the upper-side wiring unit 11, which is connected to the substrate short-circuiting unit 15, and has the via hole land 12 in accordance with a pattern corresponding to a desired mode, is formed.

[0026]

Moreover, as shown in an enlarged manner in Fig. 7, metal posts 24 each of which is made of a metal deposit body having a fine cylinder pillar shape are formed at desired positions on the via hole land 12 of the upper-side wiring unit 11 and the upper-side wiring unit 11 on the upper surface of the substrate 10 by means of photolithography and electrolytic copper plating. The height of each metal post 24 is set so as to be smaller than the thickness of a thermosetting resin sheet, which will be described later, and more specifically set to 20 to 100 μm, and it is more preferably set to be greater than the thickness of the upper-side wiring unit 11 and the via hole land 12 by 10 μm or more. In the case when the height of the metal post 24 is not greater than the thickness of the upper-side wiring unit 11 and the via hole land 12 by 10 μm or more, it sometimes becomes difficult to positively form a necessary conductor-use drill hole, which will be described later. In contrast, in the case when the height of the metal post 24 exceeds 100 μm, it becomes necessary to use a thermosetting resin sheet having a relatively great thickness, and since this makes the thickness of the resulting insulating layer greater and consequently the entire lamination-type connector bulky, this arrangement is not preferable. Moreover, the inner diameter of the cylinder hole 24H of the metal post 24 is preferably set to not

more than 80 μm; thus, it becomes possible to miniaturize the inner diameter of the intermediate conductor-use drill hole, which will be described later; consequently, since it becomes possible to form a short-circuiting unit having a smaller outer diameter in the insulating layer, it is possible to provide a greater degree of freedom upon formation of the wiring unit of the upper insulating layer.

[0027]

Moreover, photolithography and etching processes are carried out on a metal thin layer 13A on the lower surface of the substrate 10 so as to remove one portion thereof so that the lower-side wiring unit 13, which is connected to the substrate short-circuiting unit 15, and has the via hole land 14 in accordance with a pattern corresponding to a desired mode, is formed.

[0028]

Second step: in this second step, as shown in Fig. 9 in its final structure, on the upper surface of the substrate 10 including the upper-side wiring unit 11 and the metal post 24, the upper insulating layer 20 is formed, and a metal thin layer 21A, used for forming the connecting electrode and the upper surface wiring unit, is formed on the upper surface of the upper insulating layer 20, and on the lower surface of the substrate 10 including the lower-side wiring unit 13, a lower insulating layer 30 is formed, and a metal thin layer 31A, used for forming a terminal electrode, is formed on the lower surface of this lower insulating layer 30.

[0029]

More specifically, as shown in Fig. 8, the thermosetting resin sheet 20A, which has through holes 23A which have such a diameter that they are

fitted to the metal posts 24, and formed in the corresponding positions thereof, is superposed on the upper surface of the substrate 10 with the metal posts 24 being inserted into the through holes 23A, and a metal foil 21B is further superposed on the upper surface of the thermosetting resin sheet 20A. Here, a thermosetting resin sheet 30A is superposed on the lower surface of the substrate 10, and a metal foil 31B is further superposed on the lower surface of the thermosetting resin sheet 30A. In this state, a heat contact bonding process is carried out by using, for example, a vacuum pressing method so that the thermosetting resin sheet 20A and the thermosetting resin sheet 30A are cured; thus, the upper surface and the lower surface of the substrate 10 are integrally bonded as coated surfaces, with the metal foil 21B being integrally bonded to the upper surface of the thermosetting resin sheet 20A and the metal foil 31B being integrally bonded to the lower surface of the thermosetting resin sheet 30A; consequently, as shown in Fig. 9, a contact bonding lamination 1A in which the metal thin layer 21A, the upper insulating layer 20, the substrate 10, the lower insulating layer 30 and the metal thin layer 31A are stacked in this order is formed. In this case, as shown in Fig. 10 in an enlarged manner, the through holes 23A formed in the thermosetting resin sheet 20A are plugged by the heat contact bonding process so that the upper end face of each metal post 24 is covered with the upper insulating layer 20.

[0030]

As described above, with respect to the means for forming the upper insulating layer 20 and the lower insulating layer 30, the heat contact bonding means for carrying out a contact bonding process on the

thermosetting resin sheets 20A and 30A placed on the bonding surface under application of heat is utilized, and this method makes it possible to positively form an appropriate insulating layer having an even thickness very easily, in comparison with a method in which, for example, an insulating resin-layer forming solution is applied and dried thereon. With respect to the thermosetting resin sheet 20A, it is necessary to use a resin sheet which has such a sufficient thickness that the metal post 24 is not allowed to penetrate the sheet upon heat contact bonding, and more specifically, those having a thickness which sets the thickness of the resulting insulating layer to, for example, 20 to 100 μm are preferably used. Moreover, the thickness of the metal foils 21B, 31B used for forming the metal thin layers 21A, 31A through heat contact bonding is preferably set to, for example, 9 to 35 μm.

[0031]

With respect to the thermosetting resin sheet 20A, it is necessary to superpose the sheet 20A, with the through hole 23A formed therein being positioned at the corresponding metal post 34, and this positioning process is easily carried out by using position-adjusting means such as a guide pin. Moreover, in the case when a thermosetting resin sheet having appropriate material properties is used, it is not essential to preliminarily form through holes corresponding to the metal posts 24.

[0032]

The temperature at which the thermosetting resin sheets 20A, 30A and the metal foils 21B, 31B are subjected to the heat contact bonding process is set to not less than a temperature which allows the thermosetting resin sheets to soften and have an adhesive property, although it depends on

the materials of the thermosetting resin sheets 20A, 30A; therefore, normally, it is set in a range of 80 to 250°C, more preferably, 140 to 200°C. The pressing pressure in the heat contact bonding processes is set, for example, in a maximum range of, approximately 5 to 50 kg/cm$^2$, more preferably, approximately 20 to 40 kg/cm$^2$. This heat contact bonding process may be carried out under normal pressure; however, in fact, a so-called vacuum pressing method, which uses a reduced pressure in a range of approximately 5 to 100 Pa, more preferably, 10 to 50 Pa, is preferably carried out, and in this method, it is possible to effectively prevent bubbles from being entrapped between the thermosetting sheet and the bonding surface.

[0033]

Third process: in this third step, as shown in Fig. 13 in its final structure, the intermediate conductor 25, which extends downward from the upper face of the upper insulating layer 20, and is joined to the upper portion of the metal post 24, is formed so that, on the upper insulating layer 20, a short-circuiting unit 23, which has an upper end electrically connected to the metal thin layer 21 formed on the upper surface of the corresponding upper insulating layer 20, with a lower end being electrically connected to predetermined positions of the via hole land 12 of the upper-side wiring unit 11 or the upper-side wiring unit 11, is formed, and so that, on the lower insulating layer 30, a short-circuiting unit 32, which has a lower end electrically connected to the metal thin layer 31A formed on the lower surface of the corresponding lower insulating layer 30, with an upper end being electrically connected to predetermined positions of the via hole land 14 of the lower-side wiring unit 13 or the lower-side wiring unit 13, is

formed.

[0034]

More specifically, as shown in Fig. 11, at a position in which each metal post 24 is formed, a conductor-forming-use drill hole 25H, which reaches the corresponding metal post 24 from the upper surface of the contact bonding lamination 1, is formed, and at a position relating to the lower-side wiring unit 13 (a position at which the via hole land 14 is formed and other necessary positions), a short-circuiting unit forming-use drill hole 32H, which reaches the corresponding lower-side wiring unit 13 from the lower surface of the corresponding contact bonding lamination 1A, is formed.

[0035]

As described above, the depth of the conductor-forming-use drill hole 25H may be set to any depth as long as it is allowed to reach the metal post 24, and is not allowed to penetrate the upper side wiring unit 11 and the via hole land 12; therefore, the permissible range of the depth of the conductor-forming-use drill hole 25H to be formed is great so that the error range of the depth of the hole to be formed by the numeric-value controlling type drilling device can be sufficiently covered, and it becomes possible to positively form a necessary conductor-forming-use drill hole 25H. Moreover, with respect to the inner diameter of the conductor-forming-use drill hole 25H, not particularly limited, any diameter may be used as long as it is made greater than the inner diameter of the cylinder hole 24H in the metal post 24 and it achieves necessary electrical connection of the intermediate conductor to be formed; therefore, it is set to, for example, 0.03 to 0.5 mm, more preferably, 0.05 to 0.15 mm. Further, the inner diameter of the short-circuiting unit

forming-use drill hole 32H is set to, for example, 0.15 mm.

[0036]

Next, the above-mentioned contact bonding lamination 1A is subjected to a plating process, such as an electroless copper plating method and an electrolytic copper plating method, so that, as shown in Fig. 12, copper deposition is formed on the inner surface of the conductor-forming-use drill hole 25H; thus, the cylinder-shaped intermediate conductor 25, which extends in the thickness direction of the upper insulating layer 20, is formed so that a short-circuiting unit 23, made by joining the host metal 24 and the intermediate conductor 25, is formed. Here, the above-mentioned plating process forms deposition of copper on the inner surface of the short-circuiting unit forming-use drill hole 32H so that the cylinder-shaped short-circuiting unit 32, which extends in a manner so as to penetrate the lower insulating layer 30 in the thickness direction, is formed.

[0037]

As described above, as shown in Fig. 13, on the upper insulating layer 20, the short-circuiting unit 23, which are electrically connected to the metal thin layer 21 formed on the upper surface thereof and the upper-side wiring unit 11 of the substrate 10, is formed, and on the lower insulating layer 30, the short-circuiting unit 32, which are electrically connected to the metal thin layer 31A formed on the lower surface thereof and the lower-side wiring unit 13 of the substrate 10, is formed.

[0038]

Fourth step: in this fourth step, as shown in Fig. 15 in its final structure, on the upper surface of the upper insulating layer 20, a connecting

electrode 21, which is electrically connected to predetermined positions of the via hole land 12 of the upper-side wiring unit 11 or the upper-side wiring unit 11 of the substrate 10, is formed, and on the lower surface of the lower insulating layer 30, a terminal electrode 31, which is electrically connected to predetermined positions of the via hole land 14 of the lower-side wiring unit 13 or the lower-side wiring unit 13 of the substrate 10, is formed.

[0039]

More specifically, photolithography and etching processes are carried out on the metal thin layer 21A on the upper surface of the contact bonding lamination 1A to remove one portion thereof so that, as shown in Fig. 14, a connecting electrode base layer 21C having a pattern corresponding to the electrodes to be inspected of the circuit substrate to be inspected and the upper surface wiring unit 22 are formed. This connecting electrode base layer 21C is electrically connected to predetermined portions of the via hole land 12 of the upper-side wiring unit 11 or the upper-side wiring unit 11 of the substrate 10 through the short-circuiting unit 23 or through this and the upper face wiring unit 22. Further, as shown in Fig. 15, metal is deposited on the upper surface of the above-mentioned connecting electrode base layer 21C by using, for example, a plating method so that the thickness of the metal layer is increased so as to form a predetermined connecting electrode 21.

[0040]

Moreover, photolithography and etching processes are carried out on the metal thin layer 31A on the lower surface of the lower insulating layer 30 so that terminal electrodes 31, arranged on grid points in a manner so as to

be connected to the short-circuiting unit 32, are formed. The electrode pitch of these terminal electrodes 31 is set to, for example, 2. 54 mm, 1. 8 mm or 1. 27 mm.

[0041]

In the above-mentioned arrangement, in some cases, the thickness of the metal layer for forming the connecting electrode 21 or the upper-surface wiring unit 22 is desirably increased individually. For example, the connecting electrode 21 is desirably made to further stick out from the surface wiring layer by 20 μm or more, in association with the functions of an elastomer layer 40, which will be described later. In such a case, for example, a photoresist film having a film thickness corresponding to the increased thickness is formed, and this is subjected to the same patterning process so as to form a hole through which the surface of the metal layer is exposed; thus, metal is injected through this hole and deposited on the surface of the metal layer through a plating method or the like, and the photoresist film is then removed. By using such a method, for example, the connecting electrode 21 is easily formed in a desired manner so as to stick out from the surface.

[0042]

Moreover, the fourth step, that is, the step in which the connecting electrode 21 and the upper surface wiring unit 22 are formed on the upper surface of the upper insulating layer 20 with the terminal electrode 31 being formed on the lower surface of the lower insulating layer 30 is not necessarily formed in an independent manner, and one portion or the entire portion may be carried out in the second step or the third step.

[0043]

In this manner, it is possible to manufacture a lamination-type connector, which is provided as a lamination constituted by the substrate 10, the upper insulating layer 20 superposed on the upper surface of the substrate 10 and the lower insulating layer 30 superposed on the lower surface of the substrate 10, and has the connecting electrode 21 and the terminal electrode 31 placed on the upper surface and the lower surface thereof, with the connecting electrode 21 being electrically connected to the terminal electrode 31 through the short-circuiting unit 23 (intermediate conductor 25 and metal post 24), the upper-side wiring unit 11 including the via hole land 12, the substrate short-circuiting unit 23, the lower-side wiring unit 13 including the via hole land 14 and the short-circuiting unit 32.

[0044]

In accordance with such a lamination-type connector, the short-circuiting unit 23 of the upper insulating layer 20 is constituted by the metal post 24 which is formed so as to stick out upward from a predetermined portion of the via hole land 12 of the upper-side wiring unit 11 or the upper-side wiring unit 11 of the substrate 10 and the intermediate conductor 25 which extends downward from the upper surface of the upper insulating layer 20, and is joined to the upper portion of the metal post 24; therefore, since it is not formed by using the through hole which penetrates the entire lamination-type connector, it is possible to easily form the upper-side wiring unit 11 and the lower-side wiring unit 13 of the substrate 10 with a greater degree of freedom. Moreover, the conductor-use drill hole 25H is formed in the upper insulating layer 20, and the intermediate conductor 25 can be

placed inside the hole, and the depth of the conductor-use drill hole 25H is formed so that it is allowed to reach the metal post 24, and is not allowed to penetrate the upper-side wiring unit 11; therefore, since the permissible range of the depth of the conductor-use drill hole 25H to be formed is great so that the error range of the depth of the hole to be formed by the numeric-value controlling type drilling device can be sufficiently covered, and consequently, since it is possible to positively form a necessary conductor-forming-use drill hole 35, it becomes possible to positively form a short-circuiting unit 23 which is connected to predetermined portions of the via hole land 12 of the upper-side wiring unit 11 and the upper-side wiring unit 11 of the substrate 10. Here, it is necessary to make the outer diameter of the intermediate conductor 25 greater than the cylinder hole 24H of the metal post 24, and it is possible to form a metal post 24 having a cylinder hole 24 the inner diameter of which is considerably small, and consequently to form the intermediate conductor 25 having a small outer diameter; thus, it becomes possible to form the upper surface wiring unit 22 of the upper insulating layer 20 with a greater degree of freedom.

[0045]

Next, the following description will discuss an adapter device for use in circuit substrate inspection, in accordance with the present invention. Fig. 16 is a cross-sectional view which shows a structure of one example of the adapter device for use in circuit substrate inspection of the present invention. The adapter device for use in circuit substrate inspection is constituted by an adapter main body 1, and an anisotropic conductive elastomer layer (hereinafter, referred to simply as "elastomer layer") 40

which is formed on the upper surface of the adapter main body 1.

[0046]

More specifically, the adapter main body 1 is made by a lamination-type connector having a structure shown in Fig. 1, and on the surface of the adapter main body 1, the elastomer layer 40 is formed in an integrally bonded or contact state. As shown in Fig. 17, the elastomer layer 40 has a structure in which a number of conductors 41, made by an insulating elastic polymer substance E closely filled with conductive particles P, are placed on the connecting electrode 21, with the adjacent conductors 41 being mutually insulated by the insulating unit 42. The respective conductors 41 are arranged so that the conductive particles P are aligned in the thickness direction, with a conductive path extending in the thickness direction. Each of these conductors 41 may be prepared as a pressure conductor which has a reduced resistance value when pressed and compressed in the thickness direction to form a conductive path. In contrast, the insulating unit 42 is not allowed to form a conductive path in the thickness direction even when it is pressed.

[0047]

In the conductors 41 of the above-mentioned elastomer layer 40, the filling rate of the conductive particles P is preferably set to 10 volume % or more, more preferably, 15 volume % or more. In the case when the conductors are provided as the pressure conductors, if the filling rate of the conductor particles is high, this arrangement is desirable in that the predetermined electric connection is positively achieved even when the pressure force is small. However, when the electrode pitch of the connecting

electrodes 21 becomes small, it might be difficult to maintain a sufficient insulating property between the adjacent conductors; therefore, the filling rate of the conductor particles P in the conductors 41 is preferably set to not more than 40 volume %.

[0048]

In the adapter for use in circuit substrate inspection having the above-mentioned structure, the elastomer layer 40 is integrally formed on the upper surface thereof, and the conductors 41 of the elastomer layer 40 are arranged on the upper surface of the connecting electrodes 21; thus, it is possible to completely eliminate the necessity of positioning and securing the elastomer layer 40 upon carrying out electrically connecting processes, and consequently to positively achieve the necessary electrical connection even when the electrode pitch in the lead electrode area is fine. Moreover, since the elastomer layer 40 is formed integrally with the adapter main body 1, it is possible to maintain a desirable electrical connection state stably and consequently to always obtain high connecting reliability.

[0049]

In the example shown in the Figure, on the outer surface of the elastomer layer 40, each conductor 41 forms a protruding portion which sticks out from the surface of the insulating unit 42. In accordance with this example, since the degree of compression due to an applied pressure is greater in the conductor 41 than that in the insulating unit 42, it is possible to positively form a conductive path having a sufficiently low resistance value in the conductor 41, and consequently to make the change in resistance value smaller with respect to changes or variations in the applied pressure;

thus, even when the applied pressure exerted on the elastomer layer 40 is irregular, it is possible to prevent the occurrence of deviations in the conductivity between the respective conductors 41.

[0050]

In the case when the conductor 41 forms a protruding portion as described above, the height h of protrusion of the protruding portion is preferably set to 8% or more with respect to the entire thickness t ($t = h + d$, d indicates the thickness of the insulating unit 42) of the elastomer layer 40. Moreover, the entire thickness t of the elastomer layer 40 is preferably set to not more than 300% of the electrode pitch p which is defined as the center-to-center distance of the connecting electrodes 21, that is, $t \leq 3p$. When such a condition is satisfied, it is possible to reduce the change in conductivity of the conductor 41 to a sufficiently small value even upon receipt of a change in the pressure applied to the elastomer layer 40.

[0051]

In the case when the conductor 41 forms a protruding portion, it is not necessarily required to allow the entire protruding portion on the flat surface to have conductivity, and, for example, a non-formation portion of the conductive path having a width of not more than 20% of the electrode pitch may be formed on the periphery of the protruding portion. Moreover, the distance r between the adjacent conductors 41 is preferably set to have a minimum value of 10% or more of the width R of the conductors 41. When such conditions are satisfied, it becomes possible to sufficiently avoid the possibility of an electrical contact between the adjacent conductors 41 caused by deviations in the lateral direction when the protruding portion is

deformed by an applied pressure. In the above-mentioned examples, the flat surface shape of the conductors 41 is set to have a rectangular shape having the same width as the connecting electrode 21, or it may have another desired shape, such as a round shape, having a necessary area.

[0052]

With respect to the conductive particles of the conductor 41, examples thereof include: particles of metal having a magnetic property, such as nickel, iron and cobalt, or particles of an alloy of these, or particles formed by subjecting these particles to plating of metal, such as gold, silver, palladium and rhodium, or particles formed by subjecting these non-magnetic metal particles or inorganic particles such as glass beads to plating of a conductive magnetic material such as nickel and cobalt. In a method which will be described later, conductive magnetic particles made of nickel or iron, or an alloy of these, are used, and from the viewpoint of a specific electric property such as a small contact resistivity, particles which have been subjected to gold plating are preferably used. Moreover, because of no hysteresis, particles made of a conductive super-paramagnetic material may be preferably used.

[0053]

The particle size of the conductive particles is preferably set to 3 to 200 μm, more preferably, 10 to 100 μm, so as to easily deform the conductor 41 upon application of a pressure, and also to provide sufficient electrical contact between the conductive particles in the conductor 41.

[0054]

With respect to the polymer substance having insulating and elastic

properties which forms the conductor 41, a polymer substance having a cross-linking structure is preferably used. With respect to the material of a curable polymer substance to be used for obtaining the cross-linking polymer substance, examples thereof include: silicone rubber, polybutadiene, natural rubber, polyisoprene, styrene-butadiene copolymer rubber, acrylonitrile-butadiene copolymer rubber, ethylene-propylene copolymer rubber, urethane rubber, polyester-based rubber, chloroprene rubber, epichlorohydrin rubber and soft liquid-state epoxy resin. More specifically, a material for a polymer substance, which is in a liquid state prior to the curing process, and is formed into an integral part with the upper surface of the adapter main body 1 while being in a closely contact state or a bonded state after the curing process, is preferably used. From this point of view, with respect to a preferable material for a polymer substance of the present invention, liquid-state silicone rubber, liquid-state urethane rubber, soft liquid-state epoxy resin, etc. are listed. In order to improve the adhesive property to the upper surface of the adapter main body 1, an additive agent, such as a silane coupling agent and a titanium coupling agent, may be added to the material for a polymer substance.

[0055]

With respect to the material for forming the insulating unit 42, a material which is the same as the polymer substance for forming the conductor 41, or different from this, may be used; and a material which is formed into an integral part with the upper surface of the adapter main body 1 while being in a closely contact state or a bonded state after the curing process, is preferably used in the same manner.

[0056]

The insulating unit is formed in such a manner that the integrating property of the elastomer layer itself and the integrating property with respect to the adapter main body are positively improved; therefore, it is possible to increase the strength of the adapter device as a whole, and consequently to obtain superior durability against repeated compressing processes.

[0057]

The adapter device for use in circuit substrate inspection, as described above, is arranged so that a circuit substrate to be inspected is placed on the upper surface thereof while the electrode to be inspected of the circuit substrate is aligned face to face with the connecting electrode 21, with the terminal electrode 31 on the lower surface being connected to a tester through a predetermined connecting means, as well as with the entire portion being pressed so as to be compressed in the thickness direction. In this state, the conductor 41 of the elastomer layer 40 of the adapter device is in a conductive state so that a predetermined electrical connection is achieved between the electrode to be inspected and the tester.

[0058]

The above-mentioned adapter device for use in circuit substrate inspection is manufactured by forming the elastomer layer 40 on the upper surface of the adapter main body 1 as described below. First, conductive magnetic material fine particles are dispersed in a material for a polymer substance which forms an insulating, elastic polymer substance through a curing process so that an elastomer material made from a fluidizing mixture

is prepared; thus, as described in Fig. 18, the elastomer material is applied onto the upper surface of the adapter main body 1 so that an elastomer material layer 50 is formed, and this is placed in a cavity of a metal mold.

[0059]

This metal mold is constituted by an upper mold 51 and a lower mold 52, each forming an electromagnet, and the upper mold 51 is provided with a magnetic pole plate 53 which is constituted by a ferromagnetic portion (indicated by slanting lines) M having a pattern corresponding to the connecting electrodes 21 and a non-magnetic portion N which is a portion other than the former portion, and has a flat face as its lower surface, with the flat lower surface of the magnetic pole plate 53 being separated from the surface of the elastomer material layer 50 with a gap G placed in between. Here, in Figs. 18 and 19, the detailed structure of the adapter main body 1 is omitted except for the connecting electrodes 21.

[0060]

In this state, the electromagnets of the upper mold 51 and lower mold 52 are operated so that a parallel magnetic field is exerted in the thickness direction of the adapter main body 1. As a result, in the elastomer material layer 50, the portions placed on the connecting electrodes 21 are subjected to a parallel magnetic field which is stronger than that of the other portions, and exerted in the thickness direction; therefore, as shown in Fig. 19, by the parallel magnetic filed having such a distribution, the conductive magnetic particles inside the elastomer material layer 50 are collected to the portions placed on the connecting electrodes 21 through a magnetic force caused by the ferromagnetic portion M, and also oriented in

the thickness direction.

[0061]

Consequently, since the gap G is located on the surface side of the elastomer material layer 50 at this time, the polymer-substance-use material is also moved in the same manner by the shift and collection of the conductive magnetic particles so that the surface of the polymer-substance-use material, placed on the connecting electrodes 21, is allowed to rise to form a protruding conductor 41. Therefore, the thickness t1 of the insulating unit 42 thus formed is made smaller than the thickness t0 of the initial elastomer material layer 50. Then, while the parallel magnetic field is being exerted, or after the parallel magnetic field has been removed, a curing process is carried out so that the elastomer layer 40, constituted by the conductor 41 forming the protruding portion and the insulating unit 42, is integrally formed on the adapter main body 1, thereby making it possible to manufacture an adapter device.

[0062]

As shown in Fig. 20, with respect to the magnetic pole plate 53, the upper mold 51 may be provided with a magnetic pole plate 55 which is constituted by a ferromagnetic portion M having a pattern corresponding to the connecting electrodes 21 and a non-magnetic portion N which is a portion other than the former portion, with the ferromagnetic portion M sticking out downward further than the non-magnetic portion N on the lower surface of the upper mold 51. Moreover, a magnetic pole plate, which is made from a ferromagnetic material in its entire portion, and has its portion with a pattern corresponding to the connecting electrodes 21 sticking out downward

further than the other portions, may be used. In these cases also, with respect to the elastomer material layer 50, a stronger parallel magnetic field is exerted in the area of the connecting electrodes 21.

[0063]

Moreover, a metal mold which can variably change the gap between the upper mold 51 and the lower mold 52 with the parallel magnetic field being exerted is used, and at first, the upper mold 51 is placed right above the elastomer material layer 50, and the gap between the upper mold 51 and the lower mold 52 is gradually widened with the parallel magnetic field being exerted, so that the elastomer material layer 50 is allowed to rise; thereafter, a curing process may be carried out.

[0064]

In the present invention, it is not essential to have an arrangement in which the conductor 41 of the elastomer 40 sticks out from the insulating unit 42, and it may have a flat surface. In such a case, a metal mold having a structure, for example, shown in Fig. 18 is used, and the processes may be carried out without forming the gap G.

[0065]

The thickness of the elastomer material layer 50 is set to, for example, 0.1 to 3 mm. The polymer-substance-use material for the elastomer material layer 50 is preferably set to $10^4$ to $10^7$ centipoise under the condition that the viscosity at 25°C is represented by a distortion rate of $10_1 sec^{-1}$ so as to allow the conductive magnetic material particles to shift easily. The curing process of the elastomer material layer 50 is preferably carried out with the parallel magnetic field being still exerted; however, it

may be carried out after the function of the parallel magnetic field has been stopped.

[0066]

Moreover, the ferromagnetic material portion M of the magnetic pole plate 53 may be formed by a ferromagnetic material such as iron and nickel, and the non-magnetic material portion N may be formed by a non-magnetic metal such as copper, or a heat resisting resin such as polyimide, or an air layer or the like. The intensity of the parallel magnetic field to be exerted on the elastomer material layer 50 is preferably set to 200 to 20,000 gauss in the average of the cavities in the metal mold.

[0067]

The curing process, which is selected on demand depending on the material to be used, is normally carried out by a heating process. The specific heating temperature and heating time are selected on demand by taking the kinds of the polymer-substance-use material and time required for the shift of the conductive magnetic material particles of the elastomer material layer 50 into consideration. For example, in the case when the polymer-substance-use material is room-temperature curing-type silicone rubber, the curing process is carried out for approximately 24 hours at room temperature, for approximately 2 hours at 40°C, and for approximately 30 minutes at 80°C.

[0068]

The above-mentioned description has discussed the present invention by reference to one example thereof; and the present invention features that, on a substrate having a via hole land and a substrate short-

circuiting unit which extends from this via hole land in a manner so as to penetrate the substrate in the thickness direction, at least one insulating layer is formed, and that on this insulating layer, a short-circuiting unit which extends in a manner so as to penetrate it in the thickness direction is formed, with this short-circuiting unit being constituted by a metal post and an intermediate conductor which is connected to the upper end of the metal post. Therefore, the example shown in the above-mentioned Figures is provided with one insulating layer formed on the substrate; however, in the present invention, two or more insulating layers may be formed, and in such a case, the above-mentioned first to third processes are repeatedly carried out a plurality of times corresponding to the number of the insulating layers to manufacture a desired lamination-type connector.

[0069]

Examples

The following description will discuss examples of the present invention; however, the present invention is not intended to be limited by these examples.

[0070]

(Example 1)

(1) Manufacturing processes of a lamination-type connector

First process: Members, each of which is formed by stacking a copper metal thin film (11A, 13A) having a thickness of 9 μm on both of the surfaces of a substrate (10) made of a glass fiber reinforced-type epoxy resin having a thickness of 0.5 mm, are prepared, and each of these is cut into a rectangular shape having a size of 330 mm (width) × 500 mm (length), and substrate

short-circuiting unit forming-use holes (15H), each having an inner diameter of 0.15 mm, are formed therein by using a biaxial drilling device "ND-2J-18" (made by Hitachi Seiko K.K.) (see Figs. 4 and 5).

[0071]

Next, a cylinder-shaped substrate short-circuiting unit (15) is formed inside each of the substrate short-circuiting unit forming-use holes (15H), and the metal thin layer (11A) on the upper surface of the substrate 10 is subjected to photolithography and etching processes so that an upper-side wiring unit (11) having a via hole land (12) connected to the substrate short-circuiting unit (15) is formed on the upper surface thereof. Thereafter, metal posts (24) each of which has a cylinder shape having a protrusion height of 20 μm from the upper-side wiring unit (11), an outer diameter of 0.30 mm and an inner diameter of 50 μm of a cylinder hole (24H), are formed by using photolithography and electrolytic copper plating methods at predetermined portions of the via hole land (12) of the upper-side wiring unit (11) and the upper-side wiring unit (11) formed on the upper surface of the substrate (10). Here, the metal thin layer (13A) on the lower surface of the substrate 10 is subjected to photolithography and etching processes so that a lower-side wiring unit (13) having a via hole land (14) connected to the substrate short-circuiting unit (15) is formed on the lower surface thereof (see Figs. 6 and 7).

[0072]

Second process: Through holes (23A), each having a diameter of 0. 35 mm, are formed at positions corresponding to the metal posts (24) in a thermosetting resin sheet (20A) by using an NC drilling device, and after

this thermosetting resin sheet (20A) has been positioned together with the corresponding through holes (23A) and metal posts (24), this is superposed on the upper surface of the substrate (10); moreover, a metal foil (21B) is placed on the upper surface of this thermosetting resin sheet (20A) with a thermosetting resin sheet (30A) being superposed on the lower surface of the substrate (10), and a metal foil (31B) is placed on the lower surface of the thermosetting resin sheet (30A) so that these are subjected to a pressing process for 2 hours at a maximum pressing pressure of 40 $Kg/cm^2$ and a maximum temperature of 180°C under a reduced pressure of 10 Pa by using a vacuum pressing machine "MHPCV-200-750" (made by Meiki Seisakusho K.K.) so as to be contact-bonded under heat; thus, a contact bonding lamination (1A) in which the upper insulating layer (20) and the metal foil layer (21A) are stacked on the upper surface of the substrate (10), with the lower insulating layer (30) and the metal thin layer (31A) being stacked on the lower surface of the substrate (10), is formed (see Figs. 8 to 10). In the above-mentioned processes, with respect to the thermosetting resin sheets (20A, 30A), a glass fiber reinforcing prepreg "National Multi R1661" (made by Matsushita Denko K.K., thickness: 60 μm) is used, and with respect to the metal foils (21B, 31B) a peeling-type electrolytic copper foil "Peelable Copper Foil" (made by Furukawa Denko K.K.) having a thickness of 9 μm, formed on a supporting copper foil having a thickness of 70 μm, is used.

[0073]

Third Process: By using a biaxial drilling device "ND-2J-18" (made by Hitachi Seiko K.K.), conductor-forming-use drill holes (25H), each having a depth of 50 μm and an inner diameter of 100 μm, are formed at positions in

which the metal posts (24) are formed on the upper surface of the above-mentioned contact bonding lamination (1A), and at a position in which via hole land (14) is formed and other predetermined positions on the lower surface of the contact bonding lamination (1A), short-circuiting unit forming-use drill holes (32H), each having a depth of 50 μm and an inner diameter of 150 μm, are formed so as to be arranged on grid points having a pitch of 1.27 mm (see Fig. 11).

[0074]

Next, an electrolytic copper plating process is carried out on the above-mentioned contact bonding lamination 1A which has been subjected to electroless copper plating so that cylinder-shaped intermediate conductors 25 made from deposition of copper are formed inside the conductor forming-use drill holes 25H; thus, short-circuiting units (23), each formed by joining the metal post (24) and the intermediate conductor (25), are formed, and cylinder-shaped short-circuiting units (32) made from deposition of copper are formed inside the short-circuiting unit forming-use drill holes (32H) (see Figs. 12 and 13).

[0075]

Fourth Process: The metal thin layer (21A) on the upper surface of the above-mentioned contact bonding lamination (1A) is subjected to photolithography and etching processes so as to remove one portion thereof so that a connecting electrode base layer (21C) having a pattern corresponding to the electrodes to be inspected on the circuit substrate to be inspected and an upper surface wiring unit (22) are formed on the upper surface thereof (see Fig. 14).

[0076]

Moreover, a photoresist film having a thickness of 50 μm [HK350] (made by Hitachi Kasei Kogyo K.K.) is formed on the upper surface of the contact bonding lamination (1A), and this is subjected to a process by a photolithography method so as to remove a portion thereof in accordance with the pattern corresponding to the electrodes to be inspected on the circuit substrate to be inspected; thus, metal copper is injected in holes thus formed through a copper plating method, and the photoresist film is then separated so that connecting electrodes (21), each having a protrusion height of 50 μm, are formed, and gold plating having a thickness of 2 μm is applied to each of the connecting electrodes (22). Here, photolithography and etching processes are carried out on the metal thin layer (31A) on the lower surface of the lower insulating layer (30) in the contact bonding lamination (1A) so that terminal electrodes (31), arranged on grid points having a pitch of 1.27 mm, are formed, thereby manufacturing a lamination-type connector (see Fig. 15).

[0077]

The connecting electrodes of the lamination-type connector obtained by the above-mentioned method include a group of electrodes that have a round shape having dimensions of 0.25 mm in diameter and 0.35 mm in diameter, with a partial electrode pitch of 0.3 mm, and a group of electrodes each of which has a diameter of 0.45 mm with an electrode pitch of 0.6 mm.

[0078]

(2) Manufacturing processes of an adapter device

The above-mentioned lamination-type connector is used as an

adapter main body, and elastomer is formed on the upper surface of this adapter main body in the following manner. An elastomer material is prepared by mixing conductive magnetic material particles having an average particle size of 26 μm, made of nickel, in room-temperature curing-type urethane rubber at a ratio so as to form 15 volume %, and this elastomer material is applied to the surface of the adapter main body; thus, the resulting member is processed basically in accordance a method using a metal mold shown in Fig. 20. In other words, a magnetic pole plate 55 in which a ferromagnetic portion M is allowed to protrude from a non-magnetic portion N by 0.1 mm on the lower surface thereof, is used with a gap of 0.03 mm being formed between the lower surface of the ferromagnetic portion M and the elastomer material layer so as to exert a parallel magnetic field, thereby allowing the elastomer material layer to rise; then, this is left for 24 hours at room temperature to be cured so that an elastomer layer, which has conductors having a thickness t of 0.3 mm, insulating units having a thickness d of 0.27 mm and a rate of protrusion $(t - d)/t$ of the conductor of 10%, is formed, thereby manufacturing an adapter device for use in circuit substrate inspection.

[0079]

Experiment 1

With respect to the above-mentioned adapter device, a resistance measuring device "Milli Ohm Hitester" (made by Hiki Denki Sha K.K.) is used for measuring processes in which a common conductor plate is placed on the lower surface side of the substrate, with all the terminal electrodes being set in a short-circuiting state, so that an electric resistance value

between the conductor plate and each of the connecting electrodes is measured by utilizing a probe pin. As a result, it is confirmed that, with respect to all the connecting electrodes, the electric resistance value is set to a very small level of not more than 30 mΩ, thereby achieving a sufficient electrical connection between the connecting electrode and a terminal electrode to be connected thereto.

[0080]

Experiment 2

Moreover, with respect to the adapter device, the same resistance measuring device is used for measuring processes in which an electric resistance value between adjacent connecting electrodes which are to be mutually insulated from each other is measured by utilizing a probe pin; consequently, it is confirmed that each electric resistance value is set to a great level of 2 MΩ or more, thereby achieving a sufficient insulating state.

[0081]

Effects of the Invention

In accordance with the lamination-type connector of the present invention, the short-circuiting unit of the insulating layer is constituted by a metal host which is placed so as to stick out upward from the via hole land of the wiring unit in the substrate and the intermediate conductor which extends downward from the upper surface of the insulating layer, and is joined to the upper portion of the metal post, and since this arrangement does not depend on a through hole which penetrates the entire lamination-type connector, it becomes possible to form the wiring unit of the substrate easily with a great degree of freedom. Moreover, the intermediate

conductor can be placed inside a hole section formed in the insulating layer, and the depth of this hole section is set to any depth as long as it reaches the metal post without penetrating the wiring unit; therefore, since the permissible range of the depth of the hole section to be formed is great, it is possible to sufficiently cover the error range of the depth of the hole formed by a numeric-value controlling-type drilling device, and consequently to positively form a necessary hole section; thus, since it is possible to positively achieve the connection between the via hole land of the wiring unit of the substrate and the short-circuiting unit. Moreover, since the metal post having a cylinder hole with a considerably small inner diameter is formed, it becomes possible to form an intermediate conductor having a small outer diameter, and consequently to form the wiring unit of the insulating layer with a great degree of freedom.

[0082]

In its basic structure, the adapter device for use in circuit substrate inspection of the present invention is provided with connecting electrodes which are arranged in association with inspection subject electrodes of an inspection subject circuit substrate, and formed on the upper surface of an adapter main body, and terminal electrodes arranged on grid points formed on the lower surface thereof, and in this arrangement, the adapter main body is provided with the above-mentioned lamination-type connector, and an anisotropic conductive elastomer layer is integrally formed on the upper surface of the adapter main body; therefore, even in the case when the electrodes to be inspected of the circuit substrate to be inspected have a fine electrode pitch and a fine, complex pattern with a high density, it is possible

to positively achieve necessary electrical connection with respect to the circuit substrate, and also to maintain a superior electrical connection state in a stable manner even under environmental changes such as thermal history due to temperature changes; thus, it becomes possible to provide high connection reliability, to easily form the adapter main body having a desired wiring structure, and consequently to positively carry out the manufacturing processes in a very advantageous manner.

Brief Description of the Drawings

Fig. 1 is a cross-sectional view which explains a structure of one example of a lamination-type connector of the present invention.

Fig. 2 is a partial planer view which explains the layout of respective portions of the example of the lamination-type connector of the present invention.

Fig. 3 is an enlarged cross-sectional view which explains a lamination-type connector in Fig. 1.

Fig. 4 is a cross-sectional view which explains a substrate material to be used in a method for manufacturing the lamination-type connector of the present invention.

Fig. 5 is a cross-sectional view which explains a state where a substrate short-circuiting unit forming-use hole is formed in the substrate.

Fig. 6 is a cross-sectional view which explains a state where an upper-side wiring unit having a via hole land, metal posts, a substrate short-circuiting unit and a lower-side wiring unit having a via hole land are formed on the substrate.

Fig. 7 is an enlarged cross-sectional view which explains one portion

of the substrate in Fig. 6.

Fig. 8 is a cross-sectional view which explains a layout state of members constituting a contact bonding lamination.

Fig. 9 is a cross-sectional view which explains a state where the contact bonding lamination is formed.

Fig. 10 is an enlarged cross-sectional view which explains one portion of the contact bonding lamination in Fig. 9.

Fig. 11 is a cross-sectional view which explains a state where conductor-use drill holes and short-circuiting unit forming-use drill holes are formed in the contact bonding lamination.

Fig. 12 is a cross-sectional view which explains a state where an intermediate conductor is formed in each of the conductor-use drill holes and a short-circuiting unit is formed in each of the short-circuiting unit forming-use drill holes.

Fig. 13 is a cross-sectional view which explains a state where short-circuiting units are formed in an upper insulating layer of the contact bonding lamination.

Fig. 14 is a cross-sectional view which explains a state where a connecting electrode base layer and an upper surface wiring unit are formed on the upper surface of the contact bonding lamination.

Fig. 15 is a cross-sectional view which explains a finished lamination-type connector in which connecting electrodes are formed on the upper surface of the contact bonding lamination with terminal electrodes being formed on the lower surface of the contact bonding lamination.

Fig. 16 is a cross-sectional view which explains a structure of one

example of an adapter device for use in circuit substrate inspection of the present invention.

Fig. 17 is an enlarged cross-sectional view which explains an elastomer layer portion of the example of the adapter device for use in circuit substrate inspection of the present invention.

Fig. 18 is a cross-sectional view which explains a state where an adapter main body on which an elastomer material layer has been formed is set in a metal mold.

Fig. 19 is a cross-sectional view which explains a state where a parallel magnetic field is exerted in Fig. 18.

Fig. 20 is a cross-sectional view which explains another example of a metal mold to be used for forming the elastomer layer.

Fig. 21 is an explanatory drawing which shows a layout of one example of a printed circuit board.

Reference Symbols

1 adapter main body

1A contact bonding lamination

10 substrate

11 upper-side wiring unit

11A metal thin layer

12 via hole land

13 lower-side wiring unit

13A metal thin layer

14 via hole land

15 substrate short-circuiting unit

15H substrate short-circuiting unit forming-use hole

20 upper insulating layer

20A thermosetting resin sheet

21 connecting electrode

21A metal thin layer

21B metal foil

21C connecting electrode base layer

22 upper surface wiring

23 short-circuiting unit

23A through hole 24 metal post

24H cylinder hole 25 intermediate conductor

25H conductor-forming-use drill hole

30 lower insulating layer 30A thermosetting resin sheet

31 terminal electrode 31A metal thin layer

31B metal foil 32 short-circuiting unit

32H short-circuiting unit forming-use drill hole

40 anisotropic conductive elastomer layer

41 conductor 42 insulating unit

E elastic polymer substance P conductive particles

50 elastomer material layer 51 upper mold

52 lower mold M ferromagnetic material portion

N non-magnetic material portion 53 magnetic pole plate

G gap 55 magnetic pole plate

90 circuit substrate 91 functional element area

92 lead electrode 93 lead electrode area